2. Claims 1 and 8 have also been amended without prejudice to clearly indicate that the apparatus and method claimed in claims 1 and 8 provide viewing of electrical discharge over a true color image of the electrical equipment.

3. Several additional amendments have been made for the sake of clarity.

B) Novelty and Inventiveness

Independent claims 1 and 35 (method claims) and claim 8 (apparatus claim) respectively relate to the detection and location of **electrical discharges** over electrical equipment in full daylight or equivalent artificial indoor illumination.

Electrical discharges generally occur on high voltage (HV) lines and equipment due to failure of insulation or equipment components leading to a high local electric field. The term "Electrical discharge" generally relates in the art to the phenomena of partial discharge, corona, and arcing. All said three types of electrical discharge are associated with very weak UV emission, which cannot be observed in daylight or even in indoor artificial illumination.

Corona is one example of an electrical discharge. It is a partial discharge from a surface to the air that occurs when the local electric field exceeds a threshold value that under normal atmospheric conditions is about 30 kV/cm. Corona typically appears on high voltage equipment, such as insulators and conductors of power lines, and mainly caused by external defects or contamination. Corona is formed due to ionization of the air and the partial breakdown of its dielectric strength. The corona exhibits typical UV emission in the air (mainly of Nitrogen) and audio noise.

There are various known negative effects of electrical discharges in general, and to corona in particular, just to mention a few: (a) audible noise; (b) radio and TV interference (c) generation of toxic and corrosive materials as ozone and nitrogen oxides that produce nitric acid at high humidity (d) damage to the electrical equipment on which the corona appears due to the generated corrosive material; (e) ignition danger to other close objects; and (f) various of biological effects and negative health effects, as recently discussed in many papers.

Therefore, when electrical discharge appears on electrical equipment there is often a high necessity to locate and fix the failure. The fact that the electrical discharge is associated with an audible, noise and the use of ultrasonic detectors, does not help much in finding the exact location where the discharge takes place. The only exhibited sign, which could direct the

engineer to the existence of the failure, and to the location of the discharge is the UV emittance involved with the discharge. However, unfortunately the weak UV emission of corona (and other HV electrical discharges) cannot be detected and exactly located at high illumination, and particularly in daylight.

The problem is very acute particularly on HV transmission and distribution lines of electrical companies which obviously span many thousands of miles (and more), and which are very hardly accessible. The problem is also acute in transformation substations. According to the prior art maintenance crews had to work during nights in order to detect and locate the discharge problem, and they also had to repair the problem generally at dark conditions.

Working on the very high voltage poles is complicated and dangerous even during high illumination (day) conditions, but no doubt the complication becomes significantly higher during nights. The payment to the maintenance crews is also significantly higher for their work during the nights.

The only way by which an electric discharge can be detected during daytime is the observation of its UV emission in the solar blind band (240-280nm), where the sun radiation reaching the earth is practically zero due to the ozone absorption in this spectral band. The corona emission in the solar blind band is very weak in intensity and therefore it can be detected only by the use of an imager, which comprises a so called solar blind image intensifier coupled to a solar blind filter (or an image intensified SBUV image sensor). Such an imager almost totally blocks radiation out of the solar blind spectrum. However, even with such an imager (for example as disclosed by Dirscherl) that is sensitive enough to detect and display indications for single photons in the SBUV band, and with sun background noise as low as the dark noise, the electric discharge can be detected, but not exactly located, making such a device to be almost useless for fulfilling the objects as described above. This is in view of the fact that detection, without exact location of the faulty electrical component, does not enable repair. Furthermore, a detection and location of the electric discharge in which the background equipment is shown in true color is highly desirable, as it enables much more efficient and convenient work. Such a device for detection and location of electric discharge in daylight, and in true color has never been proposed in the art prior the date of the invention. In fact, the inventors have found that using a SBUV image intensifier as described in independent claims 1, and 8, provides visual indication and location of the electrical discharge even in the level of single photons, and enables

showing the background equipment in true color. Applicant comments that imagers based on the method of claim 1 and apparatus of claim 8 are presently in use by preventive maintenance crews in many utilities worldwide.

Claim 35 also provides detection and location of electric discharge in daylight by combining the solar blind image with an IR image of the electric equipment. Although a structure as in claim 35 does not show the background equipment in true color, it still enables detection and location of the electric discharge in daylight, and it also provides indication of hot regions due to current flow in the equipment, an indication which is also important for repairing the problem. Such a structure of a device for detecting and locating electric discharge has also never been proposed prior to the date of the invention.

Therefore, present claims 1, 8 and 35 provide a method and apparatus for the detection and location of electric discharges which are associated with UV emittance in full daylight. While in claims 1 and 8 the background display of the equipment is shown in its true color, in claim 35 still other advantages are obtained, such as the detection and location of hot regions in the equipment. The art has never suggested prior the date of the invention such a solution for the detection and location of electric discharge, although there was a very long felt need for many years for such a solution.

The Examiner rejects claims 1-3, 6, 8-20, 22, 24, 27, 35, 38-43, 46, 47, and 54-56 under 35 U.S.C. 103(a) as being unpatentable over Ross et al. in view of Dirscherl et al.

The Applicant believes that independent claims 1, 8, and 35 are inventive, also for the following reasons:

1. None of the publications cited by the Examiner suggests, or even hints to a device and method for detecting and locating UV emittance of electric discharge on electrical equipments in daylight, as in amended claims 1, 8, and 35. As said, prior to the date of the invention there was a very long felt need for a solution to the problem of detecting and locating of electrical discharge in electrical equipment, and only the present invention has satisfied this long felt need. The Applicant comments that any invention involves two stages: (a) a first stage in which the inventor observes a problem; and (b) a second stage in which the inventor provides a solution to the problem. In this case, neither Dirscherl nor Ross even raised the problem (i.e., detection and location of electric

discharge in electrical equipment in daylight), that the present invention solves. Dirscherl invention is targeted to the detection of emittance from combustion in flying objects, such as missiles (see abstract), and Ross invention is targeted to "determine the presence of polluting conditions, such as oil on water or certain gases in the atmosphere, or foilage disease or stage of growth. In addition, the detected conditions can be electrically recorded for subsequent re-evaluation or comparison" (col. 2, lines 18-22).

Ross, in **all** his embodiments and **all** his claims teaches a device which forms a false color combined image. A true color image is one in which the captured scenery is displayed in its original real colors. As defined by Wikipedia (The free encyclopedia - http://en.wikipedia.org/wiki/False_color): "A **true-color** image of a subject is an image that appears to the human eye just like as the original subject would: a green tree appears green in the image, a red apple red, a blue sky blue, etc. When applied to black-and-white images, *true-color* means that the perceived lightness of a subject is preserved in its depiction". In a false color image, however, one or more of the red, green and blue signals is replaced by the signal from a sensor responding to some other wavelength band, be it short wave infrared, thermal infrared etc, and usually a filter is provided to color the output of the invisible channel. The result is that objects are shown in colors which are not their natural colors and which depend on the relative signal intensity levels in the different inputs. For example, if the red channel input comes from a near-infrared sensor and if a filter will tint the infrared sensor output in red color, then healthy foliage, which reflects more strongly in near infrared, will appear bright red while dark rocks will appear to be blue-green as the input to the red channel is low. Appendix "1" shows several illustrations to true and false color applications. In Wikipedia we find: "The term "false color" is typically used to describe images whose colors represent measured intensities outside the visible portion of the electromagnetic spectrum". In the combined image, the "visible" channel of Ross displays the "visible" image using two colors, for example, blue and green, and the "invisible" channel of Ross is a tinted mono-color channel (red in the example of the foliage image – Fig. 2 of Ross), which outputs various levels of signal, relating to the "invisible" radiation emanated from the object in the view. In the apparatus of Ross the scenery is displayed in false color in order to highlight differences in the objects viewed, for example the difference between sick and healthy foliage. The Applicant invention, however, displays the visible view in true color. Therefore, by Ross teaching a false color device, he teaches away from the present invention.

This is in addition to Ross teaching of the determination between levels of invisible reflections (from foliage or oil), while the present invention teaches detection and location of electrical discharge, which is associated with UV emittance.

2. Applicant believes that one having ordinary skill in the art would not combine the knowledge of Dirscherl and Ross to form a device for detecting electric discharge in electrical equipment unless using hindsight (i.e. applying knowledge of the present invention). Ross and Dirscherl do not, even remotely address the problem that the present invention solves (i.e., detection and location of electric discharge), and there is no hint in neither of them that would motivate a skilled person to combine them. Moreover, even if someone would combine these two references, he would still not obtain the apparatus of the present invention, as the combined apparatus will be a false color apparatus. Applicant believes that Ross, by teaching a method and apparatus to combine "a composite of false colored image highlighting those portions of the object having a high degree of reflectance in the non-visible spectrum" (see abstract lines 5-8) clearly teaches away from the invention, which teaches detection and location of a phenomenon which involves emittance even in the level of single photons, and with true color image of the background.

3. Claim 35 suggests suggests imaging in both the IR and SBUV spectral regions, and to combine them in a registered manner in order to enable detection and location of electrical discharge. In this manner, the background image is the IR image, and therefore hot regions of the equipment can also be detected and located with reference to said UV emittance of electric discharge. This is still another method that none of the prior art suggests. The IR image of claim 35, though not a true color image, shows the details of the IR emittance from the electrical equipment, and thus the combination with the SBUV image enables the detection of both electrical discharges and hot regions of the equipment, that are indicative of internal defects in the electrical equipment.

4. Therefore, the Applicant believes that independent claims 1, 8, and 35 are both novel and inventive. The rest of the claims are novel and inventive in view of their dependency of inventive claims.

5. The Examiner has cited the publication of Baril against dependent claims 24, 25 and 26. The Applicant believes that said rejections of claims 24 and 25 and 26 are moot in view of the above arguments.

6. The Examiner has cited the publication of Willey (US 5,841,574) (when combined with Dirscherl and Ross) against dependent claims 59. The Applicant believes that said rejection of claim 59 is moot in view of the above arguments.

7. Applicant also encloses an Article that was published in EPRI (Electrical Power Research Institute) Internet magazine in October 1999, which describes the advantages of using a bi-spectral camera as in the invention (the DAYCOR camera mentioned in the article has actually been produced by the Applicant) for detecting and locating corona. See Appendix 2. Since this reference was published after the international filing date of this application, it is not prior art that can be used in this application. Instead, we are merely submitting this document to illustrate the success of the present claimed invention.

Claims Rejection under 35 USC 101 and 35 USC 112

The Examiner has objected to claims 36-57. All said claims are now cancelled without prejudice. Also claims 17 and 33 are now cancelled.

Conclusion

It is respectfully submitted that the current claims are patentable over the cited references and rejections. Accordingly, the applicant's request the examiner to allow these claims and an allowance is respectfully solicited.

Respectfully submitted

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